PUBLIC ROADS

A JOURNAL OF HIGHWAY RESEARCH

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

VOL. 13, NO. 12 ▽ FEBRUARY, 1933

AIR VIEW OF WOODWARD AVENUE, WAYNE COUNTY, MICHIGAN

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PUBLIC ROADS ▸▸▸ *A Journal of Highway Research*

Issued by the

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

G. P. St. CLAIR, *Editor*

Volume 13, No. 12 February, 1933

The reports of research published in this magazine are necessarily qualified by the conditions of the tests from which the data are obtained. Whenever it is deemed possible to do so, generalizations are drawn from the results of the tests; and, unless this is done, the conclusions formulated must be considered as specifically pertinent only to the described conditions.

In This Issue

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A SURVEY OF HIGHWAY TRANSPORTATION IN MICHIGAN

A REPORT OF HIGHWAY USAGE UPON TRUNK LINE, COUNTY AND TOWNSHIP HIGHWAYS AND UPON CITY STREETS OF MICHIGAN DURING 1930 AND 1931

By the Bureau of Public Roads, United States Department of Agriculture and the Michigan Highway Department

THE results of a study of highway traffic upon township, county, and trunk-line highway systems and upon city streets within the State of Michigan are given in this report. The survey was conducted under a cooperative research agreement between the Bureau of Public Roads of the United States Department of Agriculture and the Highway Department of the State of Michigan.

The work was under the general supervision of E. W. James, Chief of the Division of Highway Transport of the Bureau of Public Roads, and Grover C. Dillman, State Highway Commissioner of Michigan. The project was directly in charge of L. E. Peabody, senior highway economist, assisted by C. B. Bishop, H. E. Cunningham, D. O'Flaherty, and L. S. Tuttle, all of the Division of Highway Transport.

SUMMARY

Of the 85,080 miles of rural highways in Michigan, the trunk-line roads include 7,691 miles (exclusive of sections within incorporated areas), the county roads 17,175 miles, and the township roads 60,214 miles. The average traffic, in vehicle-miles per day, on these various systems, is as follows: Trunk-line roads, 8,804,656; county roads, 3,264,107; township roads, 1,327,801; all rural roads, 13,396,564. The average density of traffic on the trunk-line roads was found to be 1,144 vehicles per day; on the county roads 190 vehicles per day; and on the township roads 22 vehicles per day. About 14 per cent of the township mileage carries an average traffic of 5 vehicles per day or less, and 25 per cent carries 10 vehicles or less.

Of the traffic on township roads, 60 per cent originates within the local township and only 18 per cent originates outside the county. Of the traffic on county roads, 70 per cent originates inside the county and 30 per cent outside. Sixty per cent of the traffic on the trunk-line roads comes from outside the local county.

Approximately one-half of the traffic in the State, about 13,000,000 vehicle-miles per day, is on city streets. Of this total 69 per cent is local and 31 per cent nonlocal.

City streets are used by vehicles of rural origin to about the same extent as the township and county roads are used by vehicles of urban origin. The use of the trunk-line roads by urban and rural residents is approximately in proportion to the ratio of urban to rural population.

Expenditures on the various classes of highway in 1930–1931, expressed in terms of cents per vehicle-mile of traffic, were as follows: City streets, 0.78 cent; trunk-line roads, 1.05 cents; county roads, 2.37 cents; township roads, 1.29 cents.

OBJECTIVES OF THE SURVEY

The tendency of States to concentrate control of highways has greatly advanced within the last year. A system of dividing road construction or maintenance among small units of Government has resulted in inefficient use of road machinery, lack of financial ability to obtain technical direction and difficulty in coordinating highway improvements among adjacent governmental units. The interchange of traffic between township, county, and trunk-line systems and city streets produces a situation which requires the highest type of cooperation among administrative forces representing each system if efficient results are to be obtained.

Organization for the use of mass-production methods on secondary highways has taken various forms. In 1931 the Department of Highways of Pennsylvania assumed direct responsibility for more than 20,000 miles of secondary highway. Michigan legislation in the same year provided for gradual absorption of all township highways by the counties, with a financial grant to the counties from State highway funds, and with a measure of supervision of their expenditure by the highway department. North Carolina has placed all highways of the State under direct control of her highway commission. Virginia has made provision for the absorption of county highways by the State, effective July 1, 1932. A recommendation that county highways be taken over by the State has been made to the Governor of New York by a commission appointed to study the matter. Counties have taken over the entire township mileage in Iowa, and in Illinois township highway organizations are under the jurisdiction of the county superintendents of highways.

These administrative changes have resultant financial problems, the sound solution of which rests fundamentally upon the relative amounts and character of the traffic on the various classes of highway. Mutual demands for assistance among the various governmental units and conflicting opinions as to the amount of traffic interchanged rest at present upon hypothesis, or at best upon very fragmentary data. The relative responsibility of the several governmental units for the construction and maintenance of all of the highways within the State may be stated on the basis of facts obtained in extensive traffic surveys.

The Michigan transport survey is the first in which the traffic on all these highway systems—city streets, trunk lines, county highways, and township roads—has been simultaneously studied. Traffic of local and of nonlocal cars on each of these highway systems was observed at over 1,000 points covering approximately 4,000 sections of highway throughout a full year. In studying a township the use of trunk-line, county, and township roads of the township by cars owned within and outside of the township was obtained. In the case of the county, traffic use of the county and trunk-line systems by owners within and without the county was obtained.

Data as to use of city streets by local and nonlocal traffic were gathered at more than 400 points within the seven cities of Detroit, Grand Rapids, Flint, Lansing, Jackson, Ann Arbor, and Niles.

The primary objective of the survey was to obtain data indicative of the character and amount of use of the township, county, and trunk-line highways, and city streets.

A secondary objective was to obtain information on the tourist traffic in Michigan, its origin, the number of tourists and tourist cars, the length of stay, the mileage traveled, the types of accommodation used by tourists, and the value of tourist traffic to the State. It was also desired to determine the volume of city traffic dur-

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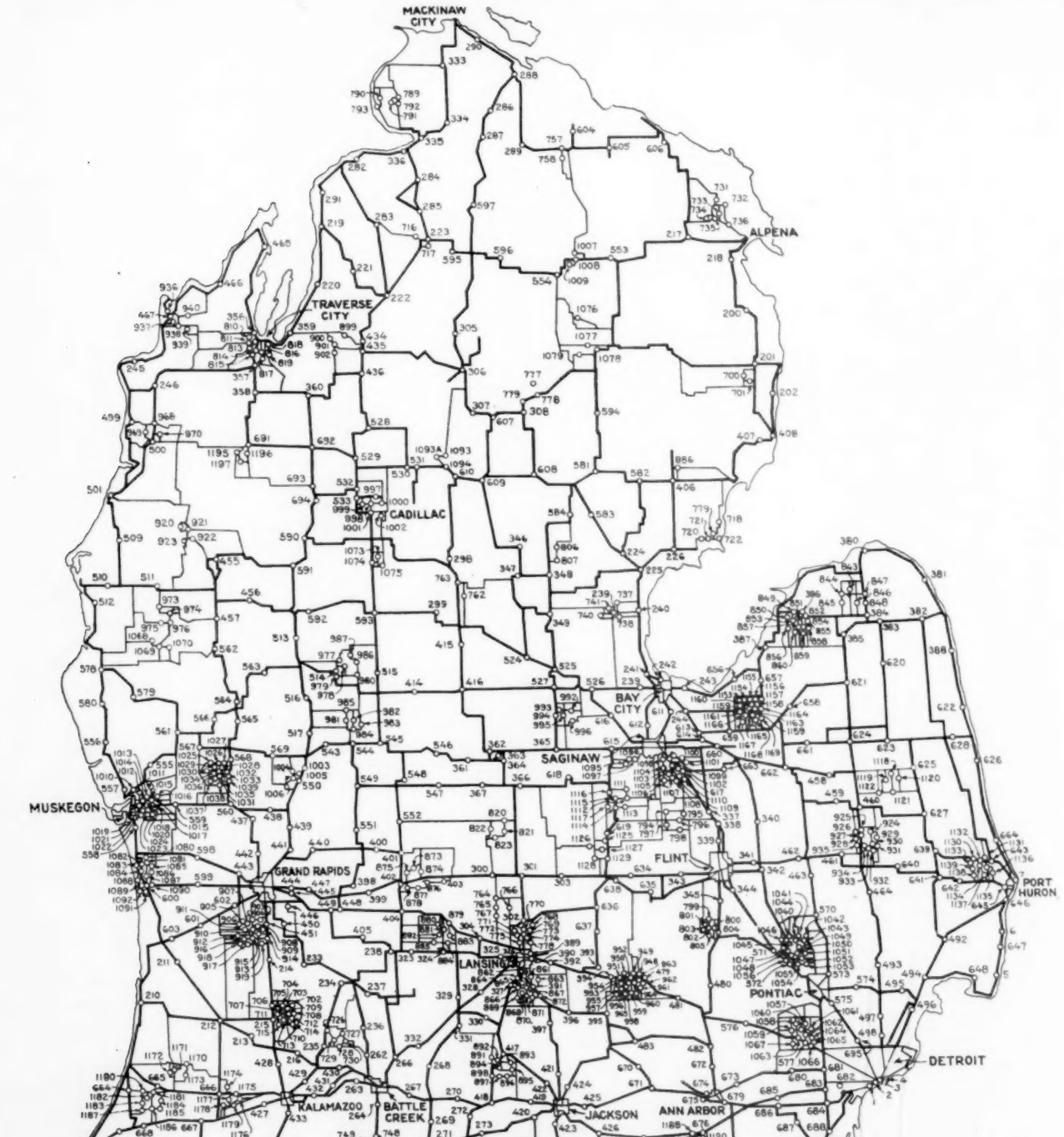


FIGURE 1.—LOCATION OF TRAFFIC STATIONS IN SOUTHERN PENINSULA

ing peak hours of travel, total street widths, effective street widths after making deductions for parked vehicles, safety zones and other obstructions, and the presence of street-car tracks.

The material relating to tourist traffic appears separately in this issue (see p. 197). The detailed study of city traffic is omitted from this report because of lack of space.

SELECTION AND OPERATION OF TRAFFIC SURVEY STATIONS

Within the State of Michigan at the start of the survey were approximately 60,000 miles of township road, 17,000 miles of county highway, 8,000 miles of trunk line, and many thousand miles of city streets. The entire township road mileage was under the jurisdiction of 1,269 township units, while 83 counties administered their respective road systems, and the State highway department constructed and maintained all trunk-line highways.

It was impractical to operate traffic survey stations upon each mile, or even upon each section of this mileage. The townships were classified into 79 homogeneous groups according to the road mileage, types of roads, assessed valuation, and population. An average township within each group was selected as representative of the group and traffic stations were distributed within each such sample township so as to obtain adequate traffic data with respect to all classifications of highway, as well as all volumes of traffic. Stations were established at typical intersections of two township roads; a county road and a township road; two county roads; a trunk-line route with either a township or a county road; and at such additional points as to cover each route of travel within the township.

In each of the cities traffic survey stations were located at intersections where the data obtained would be representative of the traffic within the area. In general, these were located upon a cordon circumscribing the city, located at or near the city limits and controlling all of the major traffic routes. In addition, other stations were located within the interior of the city to obtain an accurate sample of all traffic movements within the area. These points were selected with the assistance of the city engineer or traffic engineer of the particular city. In the city of Detroit the stations adopted by the Rapid Transit Commission in their study of vehicular traffic and reported in 1930 were used.

A list of the townships comprising each group, with the "sample" township indicated, has been prepared in mimeograph form and may be obtained on request addressed to the Bureau of Public Roads. The location of the city stations is dealt with in the section of the report concerned with city traffic.

The information of major importance obtained at survey stations had reference to the origin of each vehicle. On all township roads, county roads, and trunk-line routes separately, each vehicle was placed in one of the following classes: Truck up to and including 1½ tons, truck over 1½ tons, passenger car, bus, or trailer. Each type of vehicle was further classified as to whether the owner lived within the township in which the survey station was located. If ownership was not in the township, the vehicle was classified either as owned within the county in which the station was located, elsewhere in the State of Michigan, or as a vehicle from outside the State. The "township," "county," and "State" vehicles, as defined in the foregoing, were further subdivided into those of urban ownership and those of rural ownership. Foreign vehicles were listed without regard to urban or rural ownership.

Collection of these data necessitated the stopping of all vehicles for questioning, or upon routes where traffic was too heavy to permit the stopping of vehicles, the taking of a complete density count of vehicles and a list of all registration tag numbers. These numbers were classified by means of the Michigan Department of State records showing residence of each licensee. The method of classification of vehicles at such stations was identical with that at the stations where it was possible to stop traffic. In all cases where it was impracticable to stop cars, a minimum of approximately 2,000 license tag numbers was secured during a 10-hour period and the results applied to the complete density count of vehicles over the same period. There resulted a minimum classification by means of tag numbers of 20 per cent of all vehicles passing the station and a 100 per cent classification at all but the heaviest traffic stations.

At the survey stations located within the cities vehicles were classified by means of the tag numbers as described above. The classification of vehicles was less elaborate at these stations, cars being separated into "city" and "noncity" classifications. A "city" or "local" car was defined as one owned within the city where the station was located, all other cars were classified as "noncity" or "nonlocal." In addition, traffic during the peak hour of travel was tallied separately at all city stations, and data were obtained for each adjacent street with regard to actual street width, effective street width, width of parking space, number of traffic lanes, street-car tracks, traffic lights, and other pertinent data about the intersection as related to traffic movement.

VOLUME AND ORIGIN OF TRAFFIC ON THE DIFFERENT CLASSES OF RURAL ROUTES

The location of the survey stations upon the rural routes of the southern peninsula is shown in Figure 1. Limitations in the size of the publication and the vast mileage of rural highway, totaling approximately 85,000 miles, prohibit the presentation of all of the rural road mileage. The maps show the location of the townships selected for intensive traffic analysis, the approximate location of the township stations within each such sample township, and the location of all stations upon the trunk-line routes. The number of all classes of vehicles observed during the period July, 1930, to July, 1931, upon the rural highways totaled nearly 12,000,000. Upon city streets more than 19,000,000 cars were counted and classified.

Figure 2 shows the flow of motor vehicles upon all trunk-line routes represented to scale. The data include average daily 24-hour traffic throughout the year and, in broken line, the average maximum daily traffic.

There is considerable monthly variation in traffic from the average monthly traffic of all types of vehicles. The traffic ranged from 64 per cent of the average in January to 148 per cent in August. The variation was greater for passenger cars—from 61 to 153 per cent—than for light trucks, with 79 per cent in January and 131 per cent in October. Bus traffic was more stable than that of any other type of vehicle, varying from 92 per cent in February to 114 per cent in October. Between local highways and trunk-line routes the differences in the range were small. The lightest volume of traffic on the trunk lines was in January, and in February on both county and township highways. On the respective systems the percentages were 63, 69, and 65 of the average monthly traffic. The high month on each system was August with 148 per cent for the trunk lines, and 150 and 144 per cent for county and township highways, respectively. There

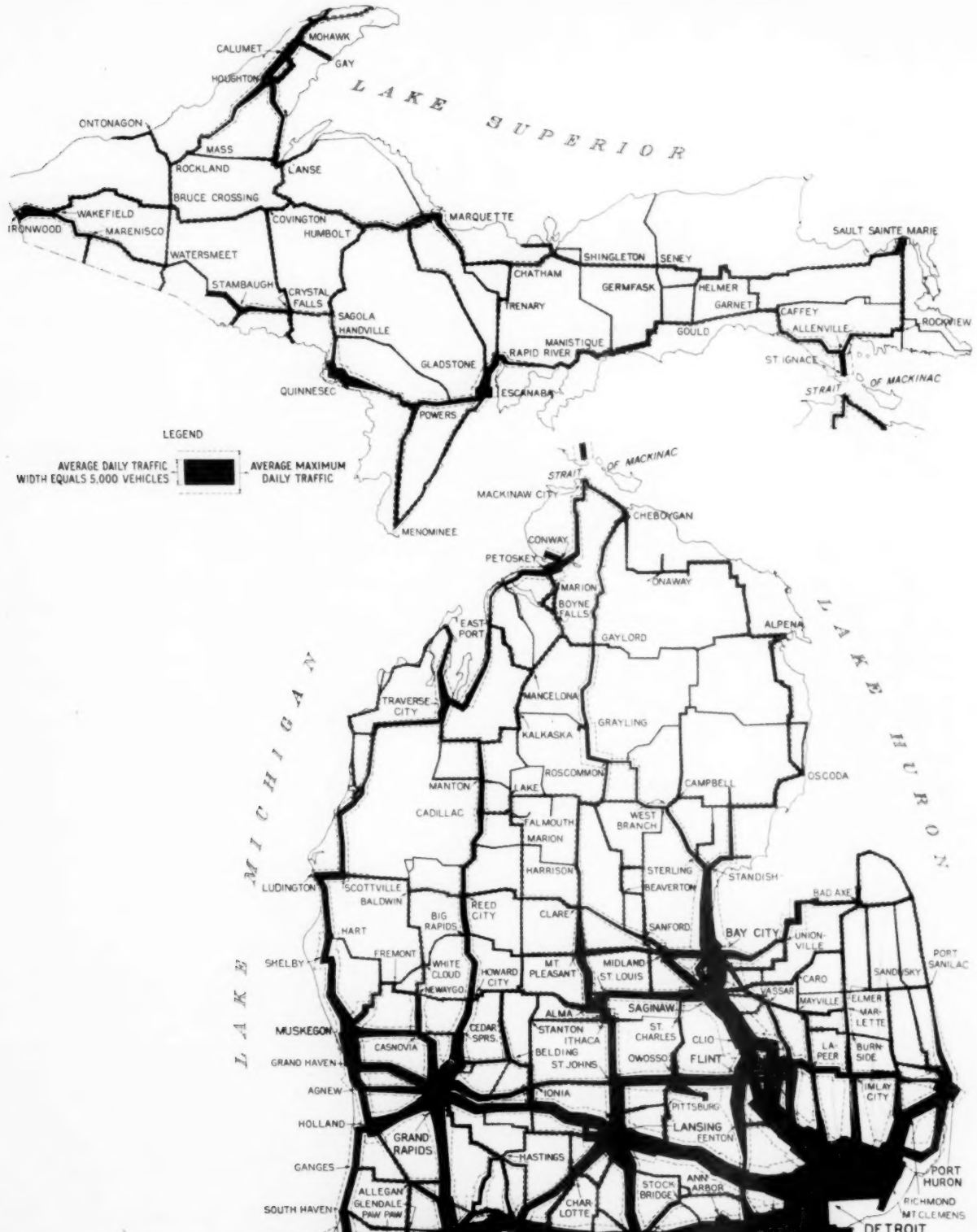


FIGURE 2.—AVERAGE DAILY TRAFFIC ON MICHIGAN TRUNK LINE HIGHWAYS, 1930–31

was great similarity in variation by days of the week on all three systems, Sunday being the heaviest day, with about 140 per cent of the average daily traffic.

Daily traffic averages within each sample township for each type of highway—township road improved and unimproved, county highways improved and unimproved, and trunk-line routes—separated by origin of the vehicle (within the township, within the county, within the State, and foreign) and for each type of vehicle (passenger cars, trucks up to and including 1½ tons, trucks over 1½ tons, trailers, and busses) were obtained from the station observations extending throughout the year. These data tabulated without separation by place of origin, may be obtained in mimeograph form from the Bureau of Public Roads. The traffic averages so obtained were applied to the total mileage of each type of highway in the corresponding township groups, resulting in an average daily vehicle-mileage by origin of vehicles upon the several political classes of highway. These daily vehicle-miles and the mileages of the several classes of highway within the township groups are tabulated in Table 1. The figures are summarized and corresponding percentages given in Table 2.

TABLE 1.—*Average daily vehicle-miles on township, county and trunk-line highways of township groups, classified according to township, county, or other origin*

Group of townships represented by—		Township roads in group	Travel on township roads from—			County roads in group	Travel on county roads from—			Trunk-line roads in group	Travel on trunk-line roads from—		
Township	County		Township	County	Other [1]		Township	County	Other [1]		Township	County	Other [1]
		Miles	*Vehicle-miles*	*Vehicle-miles*	*Vehicle-miles*	*Miles*	*Vehicle-miles*	*Vehicle-miles*	*Vehicle-miles*	*Miles*	*Vehicle-miles*	*Vehicle-miles*	*Vehicle-miles*
Ewing	Marquette	251.0	9,036	251	1,757	3.5	256	200	203	0.			
Colfax	Oceana	311.1	1,822	1,565	1,627	1.4	102	80	81	5.3	975	1,378	3,583
Wilson, Bay de Noc	Kalkaska, Delta	710.8	7,940	1,606	772	62.9	929	895	580	0.			
Elk	Lake	738.4	5,586	1,596	6,705	104.7	1,241	435	1,188	18.2	200	382	619
Gourley	Menominee	699.5	7,695	3,497	699	157.2	3,616	1,415	314	0.			
Logan	Mason	854.0	3,322	1,350	1,599	176.5	2,462	3,580	1,588	22.9	710	2,931	5,725
Maple Ridge	Alpena	595.1	5,115	1,988	697	158.6	6,027	14,274	9,516	1.0	184	260	676
James	Saginaw	449.8	8,702	7,352	449	133.3	9,064	32,259	3,732	4.0	736	1,040	2,704
Friendship	Emmet	787.3	1,575	787	787	211.4	2,537	8,879	5,285	6.6	1,214	1,716	4,462
Whitney	Arenac	836.8	3,347	837	3,347	173.3	3,575	1,367	1,534	.3	55	78	203
Mount Forest	Bay	974.5	6,822	5,847	4,872	303.1	27,582	17,580	13,943	18.5	6,456	8,399	24,402
Flynn	Sanilac	1,197.4	4,790	3,592	1,197	388.3	17,085	18,250	20,192	17.2	1,858	2,683	3,646
Montrose	Genesee	1,126.1	22,522	7,883	3,378	617.9	42,635	64,880	46,960	10.7	535	10,657	20,266
Reading	Hillsdale	991.2	19,702	6,898	3,965	516.0	44,892	26,832	28,380	29.7	5,584	3,950	4,039
Hinton	Mecosta	616.0	3,610	934	934	186.4	6,710	3,728	8,761	6.9	1,270	1,794	4,664
Columbia	Van Buren	786.4	7,443	1,573	3,942	229.6	11,939	12,858	19,746	4.7	865	1,222	3,177
Riley	Clinton	1,253.3	18,800	8,773	5,013	532.1	20,220	17,559	18,091	9.3	484	2,046	6,017
Fulton	Gratiot	1,231.1	13,164	2,336	1,784	506.2	31,891	27,335	43,027	22.4	1,949	3,584	3,942
Carlson, Hudson	Gogebic, Mackinac	743.4	4,835	1,020	1,020	59.6	4,351	3,397	3,457	343.6	8,590	10,308	52,914
Secord	Gladwin	841.5	9,256	5,890	7,574	32.3	2,358	1,841	1,873	149.1	3,728	8,797	14,910
Franklin	Houghton	792.6	11,889	10,304	793	49.2	3,592	2,804	2,854	137.6	26,006	135,261	33,987
Southbranch	Crawford	485.4	485	485	485	95.2	95	190	476	156.3	2,032	2,188	22,820
Elmer, Manistique	Oscoda, Schoolcraft	706.6	2,120	707	707	98.9	3,659	989	692	115.0	24,725	15,065	25,760
Warner	Antrim	836.1	6,689	836	2,508	124.7	748	1,496	2,120	172.6	10,011	5,868	45,566
Lake	Roscommon	622.6	3,113	1,245	623	89.8	1,257	718	1,976	127.5	4,335	5,355	28,815
Briley	Montmorency	760.8	9,130	1,522	5,326	115.0	2,070	230	230	185.1	15,363	4,072	12,587
Forest	Cheboygan	707.4	1,415	0	1,415	110.9	6,498	2,694	4,383	103.5	19,768	16,560	39,744
Arvon	Baraga	850.5	4,919	4,157	1,606	103.1	1,650	1,546	619	159.6	11,491	5,905	3,192
Hatton	Clare	594.7	2,974	3,568	1,784	131.7	1,185	2,766	1,317	135.8	1,086	14,123	52,419
Reno	Iosco	815.9	7,343	2,448	3,264	142.9	2,429	857	1,143	147.6	27,158	38,376	99,778
Middle Branch	Osceola	1,077.1	4,840	2,331	1,078	166.8	2,335	2,502	1,334	137.4	3,847	8,519	24,182
Gustin	Alcona	682.1	4,775	1,364	682	138.1	2,072	552	276	154.5	7,570	12,669	21,476
Greenland	Ontonagon	881.0	12,334	881	881	200.6	38,716	6,219	4,614	154.6	10,049	6,648	20,716
Pleasanton, Bates	Manistee, Iron	824.2	7,498	5,450	1,250	199.3	6,378	10,962	3,388	154.1	9,708	32,053	48,696
Dafter, Springville	Chippewa, Wexford	635.1	3,342	635	635	249.7	14,483	26,468	12,235	100.7	11,782	7,855	9,264
Norway	Dickinson	1,478.5	22,178	2,957	1,478	407.4	10,592	2,852	815	237.2	251,906	96,778	91,085
Palmyra	Lenawee	780.9	11,284	6,848	1,845	280.3	23,265	72,598	28,310	112.6	12,836	76,230	131,855
Saint Charles	Saginaw	566.1	5,962	2,414	1,132	125.2	6,886	13,772	15,650	139.3	10,587	22,288	22,149
Martiney	Mecosta	751.6	5,178	2,756	2,068	120.4	2,649	3,612	2,528	79.5	1,192	7,950	12,164
Empire	Leelanau	717.7	2,992	1,314	2,032	163.6	4,090	4,254	9,816	128.3	4,106	3,336	7,698
Mattison	Branch	1,110.0	12,210	6,660	4,440	261.0	6,003	10,179	8,091	145.6	5,533	8,736	19,947
Almena	Van Buren	1,100.1	16,501	6,600	7,086	223.5	20,940	5,797	18,484	145.8	7,727	22,891	34,992
Riverside	Missaukee	1,033.1	5,821	1,251	1,907	203.8	4,484	2,038	2,242	122.1	5,372	3,175	14,652
Mount Haley	Midland	1,060.6	10,606	4,516	3,181	270.8	5,958	3,250	3,791	114.8	2,066	4,822	12,398
Pierson	Montcalm	833.1	12,477	3,269	22,004	399.4	8,787	10,384	8,787	135.0	12,420	19,170	157,680
Barry	Barry	964.6	18,327	3,858	10,821	309.7	25,705	11,769	37,783	137.1	16,863	21,388	74,034
Athens	Calhoun	1,014.5	10,145	3,044	2,029	287.5	12,075	5,450	7,475	132.3	19,051	31,752	27,386
Pokagon	Cass	1,140.0	19,380	10,260	5,700	269.2	8,076	6,461	9,960	186.3	13,600	56,263	153,884
Rush	Shiawassee	973.6	13,738	2,948	1,473	379.7	20,884	18,985	7,974	117.4	19,019	59,404	72,084
Ionia	Ionia	932.1	16,066	4,749	2,234	340.5	91,594	30,645	36,774	141.1	79,016	31,606	101,874
Springport	Jackson	788.3	11,129	3,200	5,565	253.7	14,461	8,880	13,700	139.6	9,353	8,655	22,476
Fenton	Genesee	827.9	37,150	17,762	7,240	349.2	60,062	49,237	36,666	122.8	78,838	112,485	64,470
Saline	Washtenaw	965.5	19,310	5,793	4,828	292.5	28,958	8,190	18,428	160.2	21,627	35,885	232,931
Bangor	Van Buren	760.8	13,491	3,057	2,554	350.1	27,308	19,256	21,006	172.4	27,929	35,514	32,411
De Witt	Clinton	897.2	22,209	3,775	14,862	323.0	23,256	16,796	51,034	153.0	27,999	49,572	302,634
Farmington	Oakland	607.1	24,154	4,228	13,920	423.5	59,290	61,408	158,812	163.4	89,707	66,014	754,908
Clyde	Saint Clair	879.6	6,418	5,050	880	223.5	3,800	6,258	1,341	106.5	5,644	30,140	16,294
Moscow	Hillsdale	956.5	8,927	5,101	2,550	180.2	7,568	8,289	11,172	83.6	5,434	19,228	168,621
Goodland	Lapeer	654.0	7,372	2,788	3,277	238.0	8,806	6,188	12,376	79.6	2,866	5,890	47,282
Garfield	Grand Traverse	740.2	21,237	4,615	4,980	195.1	31,606	10,430	15,023	105.2	60,806	19,778	97,100
Grand Haven	Ottawa	1,453.0	23,667	2,906	8,184	315.4	105,559	33,132	38,479	169.2	58,205	38,916	191,027
Danby	Ionia	834.5	13,414	4,173	6,250	258.1	11,873	15,744	17,035	104.0	5,200	34,736	228,384
Burr Oak	St. Joseph	939.4	13,098	5,438	2,249	271.4	16,013	9,499	10,042	99.3	7,745	27,010	147,163
Ashland	Newaygo	873.5	11,874	1,582	3,163	276.4	14,373	3,593	6,634	118.5	24,530	17,894	97,881
Martin	Allegan	969.7	26,117	5,098	4,286	314.8	41,239	8,185	17,314	76.6	16,163	17,924	109,232
Fairgrove	Tuscola	780.6	16,025	3,357	1,289	206.7	16,123	10,542	6,408	99.2	13,690	12,896	15,178
Bridgeport	Saginaw	868.6	9,878	6,975	1,737	276.5	16,590	37,604	14,931	108.3	15,920	134,400	269,992
Independence	Oakland	665.3	9,248	4,657	1,996	233.8	18,470	19,172	12,625	138.7	17,199	66,853	266,443
Handy	Livingston	652.3	13,072	1,868	2,801	270.3	21,354	22,165	11,082	106.3	23,173	16,476	276,061
Winsor	Huron	677.0	19,760	7,105	2,165	314.5	35,224	32,708	13,838	115.4	31,850	30,696	20,310
Byron	Kent	665.6	21,483	6,974	3,407	279.6	45,556	44,712	31,303	123.6	8,776	133,982	157,096
Delhi	Ingham	594.1	14,726	8,270	1,595	296.3	25,778	36,149	8,296	133.4	71,636	247,857	155,278
Muskegon	Muskegon	440.0	9,240	440	440	420.6	61,828	5,047	3,785	125.4	136,310	44,642	65,459
Total		60,214.0	803,814	279,164	244,823	17,175.4	1,273,722	994,467	995,918	7,690.9	1,442,218	2,044,974	5,317,464

[1] Includes vehicles classified as "State" and "Foreign."

TABLE 2.—*Traffic upon township, county, and trunk-line highway systems originating within the township, within the county, or elsewhere*

Road type	Origin	Daily vehicle-miles	Percentage of total	Percentage of total traffic on rural roads
Township road	Township	803,814	60.5	9.9
	County	279,164	21.0	
	Other [1]	244,823	18.5	
		1,327,801	100.0	
County road	Township	1,273,722	39.0	24.4
	County	994,467	30.5	
	Other [1]	995,918	30.5	
		3,264,107	100.0	
Trunk line	Township	1,442,218	16.4	65.7
	County	2,044,974	23.2	
	Other [1]	5,317,464	60.4	
		8,804,656	100.0	
Total rural roads		13,396,564		100.0

[1] Includes vehicles from outside the State of Michigan.

Traffic on rural roads totals 13,400,000 vehicle-miles per day. Sixty-six per cent of this traffic is carried by the trunk-line routes, which constitute 9 per cent of the rural mileage; 24 per cent of the traffic is carried by the county roads, which are 20 per cent of the rural mileage. The township highways carry but 10 per cent of the rural road traffic, although the mileage of township roads is 71 per cent of all rural mileage. The distribution of traffic by origin of vehicles varies widely between the three highway systems. Upon the township roads more than 60 per cent of the traffic originates within the local township and more than 81 per cent within the local county, while upon trunk-line routes more than 80 per cent of the traffic originates at points outside the township in which the station is located, and more than 60 per cent at points outside the county. Traffic volumes per day averaged 22 vehicles upon the township roads, 190 vehicles on county roads and 1,144 vehicles upon the trunk-line routes.

Township roads are a relatively small factor in the total traffic movement, producing but one-tenth of the total vehicle-miles, with more than 60 per cent of the township road usage originating within the township.

USE OF RURAL ROADS BY MICHIGAN VEHICLES OF CITY AND RURAL OWNERSHIP

It will be recalled that cars originating at points outside Michigan were classified by field recorders simply as "foreign" without separation into vehicles of city or rural ownership. All cars bearing Michigan tags were classified with respect to city or rural ownership.

Using the method previously described for obtaining traffic volumes by unit of origin, data for Michigan vehicles divided between cars owned within the cities and those rurally owned are tabulated in Table 3. These data are further condensed for convenience in Table 4.

Two-thirds of the usage of township roads is by cars owned rurally, and this ratio declines to 44 per cent upon county roads and to 19 per cent upon the trunk-line system. City-owned cars produce nearly 70 per cent of the traffic upon the rural highway system, and nearly 75 per cent of their travel is upon the trunk-line system.

Approximately 5 per cent of the travel of city-owned cars is upon the township road system. But a small portion of the average trip of a city-owned car is over the township roads, and the use of county highways by the city dweller is about four times as great as his use of the township roads.

USE OF RURAL HIGHWAYS BY FOREIGN TRAFFIC

Motor vehicles from States other than Michigan use the trunk-line routes of the rural highways almost exclusively. Foreign vehicles produce a total of 1,115,752 vehicle-miles per day upon the rural highway systems. Nearly 86 per cent of all foreign traffic is carried by the trunk-line system, and approximately one per cent of the foreign traffic is carried by the township roads of Michigan. Detailed figures are presented in Table 5.

Slightly over 8 per cent of all travel upon the rural highways is by foreign vehicles. They constitute 10.8 per cent of the use on trunk lines, 4.5 per cent upon the county highways, and 1.1 per cent on township roads.

LOCAL AND NONLOCAL TRAFFIC ON CITY STREETS

The total use of city streets, expressed in vehicle-miles, was developed from the figures of gasoline consumption of the State. These figures indicate a total consumption of 725,386,562 gallons from July 15, 1930, to July 15, 1931, the dates of the survey. Replies to more than 5,000 questionnaires, distributed to motorists throughout the State during the period of the survey, in connection with a study of the highway finance of the State, give an average travel of 13.4 miles per gallon for all types of vehicle. Applying this average mileage per gallon to the indicated consumption within Michigan and reducing the resulting quantity to a daily basis, the average daily travel upon all rural roads and city streets is 26,600,000 vehicle-miles. From this figure may be taken the average daily vehicle mileage upon rural roads, 13,400,000, leaving an average daily use of city streets of 13,200,000 vehicle-miles.

Traffic in each city is composed of two important elements—the movement of vehicles owned within the city, or local traffic, and the movement of vehicles owned elsewhere, or nonlocal traffic.

In order to effect this separation of city traffic, 7 cities ranging in population from 10,000 to more than 1,500,000 were selected for field observation and classification of the traffic moving within them. The sample cities were Detroit, Grand Rapids, Flint, Lansing, Jackson, Ann Arbor, and Niles. A complete statement of detailed methods and results of this study is published in an appendix. Briefly, the city traffic survey involved a selection of more than 400 stations at which license tag numbers were recorded and later classified as to residence of the owners by reference to registration records. In the determination of the percentage of local use, the data collected on through streets and on local streets were analyzed separately. The percentages of local and nonlocal use in each city were computed separately for through and local streets and the results weighted by the relative mileages of each class of city streets. The results are shown in Table 6.

Examination of this table discloses that there is a uniform increase in the percentage of local traffic with increase in the size of city, both on through and nonthrough streets; that the percentage of local traffic on nonthrough streets is considerably in excess of the percentage upon through streets and that the differentials, in percentages of local use, between through and nonthrough streets are considerably lessened as the size of the city increases.

TABLE 3.—*Average daily vehicle-miles on township, county, and trunk-line roads of township groups classified according to rural or city origin*

Group of townships represented by—		Township roads		County roads		Trunk-line roads	
Township	County	Rural origin	City origin	Rural origin	City origin	Rural origin	City origin
		Vehicle-miles	*Vehicle-miles*	*Vehicle-miles*	*Vehicle-miles*	*Vehicle-miles*	*Vehicle-miles*
Ewing	Marquette	10,542	251	293	366		
Colfax	Oceana	3,422	1,556	117	146	1,104	4,832
Wilson, Bay de Noc	Kalkaska, Delta	9,240	1,422	1,321	1,132		
Elk	Lake	11,076	3,692	1,885	1,047	528	637
Gourley	Menominee	10,492	700	4,873	314		
Logan	Mason	10,248	1,708	5,472	2,294	2,450	6,229
Maple Ridge	Alpena	10,117	3,571	14,433	16,970	242	1,062
James	Saginaw	10,795	5,847	16,529	28,260	833	3,647
Friendship	Emmet	1,575	787	6,342	8,667	1,375	6,017
Whitney	Arenac	4,184	2,510	3,986	1,560	62	274
Mount Forest	Bay	9,745	6,822	28,188	30,310	4,329	33,762
Flynn	Sanilac	5,987	3,592	24,463	30,676	2,408	5,676
Montrose	Genesee	23,649	10,135	47,578	105,043	4,334	25,937
Reading	Hillsdale	19,824	11,894	47,987	44,376	4,663	7,663
Hinton	Mecosta	4,312	1,232	10,252	8,761	1,437	6,291
Columbia	Van Buren	6,291	2,359	14,235	25,486	979	4,285
Riley	Clinton	23,813	7,520	34,054	22,348	1,767	6,333
Fulton	Gratiot	14,773	3,693	43,027	57,707	4,010	5,339
Carlson, Hudson	Gogebic, Mackinac	5,204	743	4,975	6,230	20,616	35,311
Secord	Gladwin	12,622	10,098	2,696	3,376	8,797	183392
Franklin	Houghton	18,230	3,963	4,107	5,143	68,387	115,,72
South Branch	Crawford	485	485	190	476	4,220	21,257
Elmer, Manistique	Oscoda, Schoolcraft	2,826	707	2,571	2,670	15,870	43,700
Warner	Antrim	7,525	1,672	2,743	1,621	15,189	42,805
Lake	Roscommon	4,981	623	2,155	1,616	11,985	24,098
Briley	Montmorency	11,412	4,565	2,300	230	20,361	10,551
Forest	Cheboygan	2,122	707	2,551	1,885	11,592	24,736
Arvon	Baraga	14,458	4,252	1,856	1,650	8,938	11,172
Hatton	Clare	4,758	2,974	3,161	1,976	7,741	52,419
Reno	Iosco	10,607	4,080	3,287	1,000	11,218	42,656
Middle Branch	Osceola	6,463	3,231	3,169	3,002	6,870	28,717
Gustin	Alcona	5,457	1,364	2,348	414	12,514	27,656
Greenland	Ontonagon	12,334	881	44,533	4,012	18,707	14,842
Pleasanton, Bates	Manistee, Iron	11,539	8,242	9,766	10,164	16,797	59,174
Dafter, Springville	Chippewa, Wexford	3,811	635	23,222	26,718	10,271	15,306
Norway	Dickinson	17,742	7,392	8,148	5,704	126,664	275,625
Palmyra	Lenawee	16,399	6,247	47,371	65,310	31,753	91,994
Saint Charles	Saginaw	6,793	3,397	10,016	25,290	11,840	40,954
Martiney	Mecosta	6,764	2,255	5,057	3,492	7,076	12,561
Empire	Leelanau	3,588	1,435	6,871	8,507	5,132	7,955
Matteson	Branch	15,540	6,660	7,569	7,569	10,483	21,112
Almena	Van Buren	20,902	8,801	14,304	12,740	14,143	45,927
Riverside	Missaukee	5,166	2,066	5,706	3,057	7,082	15,507
Mount Haley	Midland	13,788	4,242	8,395	4,604	5,970	12,743
Pierson	Montcalm	15,829	29,158	12,781	14,778	24,705	153,765
Barry	Barry	21,221	6,752	41,810	31,589	37,702	67,042
Athens	Calhoun	10,145	6,087	13,800	10,925	21,433	53,449
Pokagon	Cass	21,660	12,540	10,230	11,037	22,729	135,999
Rush	Shiawassee	12,657	2,921	28,478	19,365	36,511	111,060
Ionia	Ionia	17,710	7,457	59,928	96,702	40,072	164,382
Springport	Jackson	11,824	4,730	16,237	19,535	12,983	25,547
Fenton	Genesee	13,246	19,043	31,079	113,141	37,086	210,848
Saline	Washtenaw	18,344	10,620	26,910	27,788	28,996	188,395
Bangor	Van Buren	13,694	6,847	23,457	36,760	16,895	70,512
De Witt	Clinton	24,224	16,150	39,729	49,742	53,856	302,787
Farmington	Oakland	24,285	17,606	73,688	197,351	114,380	772,227
Clyde	Saint Clair	8,796	4,398	6,258	5,140	15,868	35,358
Moscow	Hillsdale	11,478	2,870	13,335	12,974	15,048	114,281
Goodland	Lapeer	11,772	4,578	18,090	13,804	12,020	43,064
Garfield	Grand Traverse	15,544	19,985	21,851	33,362	39,029	121,927
Grand Haven	Ottawa	15,983	15,983	53,618	110,705	31,640	221,652
Danby	Ionia	18,359	7,510	24,003	19,874	19,552	232,960
Burr Oak	Saint Joseph	11,273	8,455	14,927	18,184	11,916	102,875
Ashland	Newaygo	12,229	6,988	13,267	10,780	19,078	116,130
Martin	Allegan	31,030	7,758	47,220	16,684	22,903	105,095
Fairgrove	Tuscola	14,051	5,464	17,156	15,709	17,459	24,006
Bridgeport	Saginaw	11,292	6,080	29,309	39,263	50,793	353,816
Independence	Oakland	8,649	5,322	17,067	30,394	40,362	299,315
Handy	Livingston	13,046	3,914	35,680	18,110	19,134	283,502
Winsor	Huron	18,279	6,093	42,458	38,684	36,120	46,045
Byron	Kent	25,293	6,656	64,308	53,404	22,742	237,559
Delhi	Ingham	15,447	10,694	31,704	38,223	55,228	390,195
Muskegon	Muskegon	4,840	5,720	27,339	35,330	59,440	178,444
Total		883,801	429,387	1,384,819	1,733,256	1,456,417	6,393,132

TABLE 4.—*Traffic of Michigan vehicles on rural highways by class of highway and situs of ownership*

Highway type	Situs of ownership	Daily vehicle-miles	Percentage
Township road	City	429,387	32.7
	Rural	883,801	67.3
County road	City	1,733,256	55.6
	Rural	1,384,819	44.4
Trunk line	City	6,393,132	81.4
	Rural	1,456,417	18.6
Total rural roads	City	8,555,775	69.7
	Rural	3,725,037	30.3

TABLE 5.—*Daily use of rural highways by Michigan and non-Michigan vehicles*

Highway type	Daily vehicle-miles					Percentage of foreign vehicle-miles
	Foreign vehicles	Percentage	Michigan vehicles	Percentage	Total	
Township road	14,613	1.3	1,313,188	10.7	1,327,801	1.1
County road	146,032	13.1	3,118,075	25.4	3,264,107	4.5
Trunk line	955,107	85.6	7,849,549	63.9	8,804,656	10.8
Total	1,115,752	100.0	12,280,812	100.0	13,396,564	8.3

TABLE 6.—*Origin of traffic on through and local streets in seven Michigan cities*

City and type of street	Percentage of street mileage	Origin of traffic		
		Local	Non-local [1]	Non-Mich.
Niles (population, 11,326).		*Per cent*	*Per cent*	*Per cent*
Through	13.1	41.2	22.1	36.7
Nonthrough	86.9	60.5	19.0	20.5
Weighted average		58.0	19.4	22.6
Ann Arbor (population, 26,944).				
Through	11.9	45.6	46.3	8.1
Nonthrough	88.1	64.0	29.9	6.1
Weighted average		61.8	31.9	6.3
Jackson (population, 55,187).				
Through	7.5	60.5	30.4	9.1
Nonthrough	92.5	73.8	23.0	3.2
Weighted average		72.8	23.6	3.6
Lansing (population, 78,397).				
Through	8.9	56.4	37.6	6.0
Nonthrough	91.1	70.6	26.5	2.9
Weighted average		69.3	27.5	3.2
Flint (population, 156,492).				
Through	5.9	66.3	30.3	3.4
Nonthrough	94.1	80.4	17.7	1.9
Weighted average		79.6	18.4	2.0
Grand Rapids (population, 168,592).				
Through	6.5	72.8	21.9	5.3
Nonthrough	93.5	80.9	16.6	2.5
Weighted average		80.4	16.9	2.7
Detroit (population, 1,568,662).				
Through	3.2	73.1	22.4	4.5
Nonthrough	96.8	81.1	15.2	3.7
Weighted average		80.9	15.4	3.7

[1] Exclusive of traffic from outside the State.

TABLE 7.—*Traffic on each class of highway in Michigan distributed according to origin or character*

Road type	Origin or character	Daily vehicle-miles	Percentage of total for type	Percentage of total State traffic
Township roads	Township	803,814	60.5	5.0
	County	279,164	21.0	
	Other	244,823	18.5	
		1,327,801	100.0	
County roads	Township	1,273,722	39.0	12.2
	County	994,467	30.5	
	Other	995,918	30.5	
		3,264,107	100.0	
Trunk lines	Township	1,442,218	16.4	33.1
	County	2,044,974	23.2	
	Other	5,317,464	60.4	
		8,804,656	100.0	
All rural roads		13,396,564		50.3
City streets	Local	9,131,388	69.0	49.7
	Nonlocal	4,102,507	31.0	
		13,233,895	100.0	
Total State traffic		26,630,459		100.0

The seven cities contain approximately 63 per cent of the Michigan urban population and it was necessary to estimate the percentages of local and nonlocal use for the remaining 37 per cent upon the basis of the data obtained in the seven cities. This was done by examining the relationship between the population of the cities and the percentage of local use and, as a check, establishing the relationship between the ratio of through streets to total street mileage of each city and the percentage of local use. Both of these relationships are fully discussed in the appendix. Combining the estimates of local use obtained by these relationships with the percentages observed in the seven sample cities resulted in an average local use in all cities of Michigan amounting to 69 per cent of the total urban traffic of the State. A separation of the total urban traffic of 13,200,000 daily vehicle-miles upon this basis, results in local use of city streets of 9,100,000 daily vehicle-miles and nonlocal use of 4,100,000 daily vehicle-miles.

TRAFFIC DATA SUMMARIZED

As a summary of the facts brought out in the preceding pages, the data on rural roads in Table 2 are repeated in Table 7, and combined with the figures obtained for traffic on city streets, so as to show the relative distribution of local and non-local traffic on the different classes of highway.

The predominantly local character of the township roads is indicated by the 60.5 per cent of traffic on these roads which originates within the township, while only 18.5 per cent comes from outside the county. Similarly 69.5 per cent of the traffic on county roads is by vehicles originating within the county. That the trunk-line roads are essentially arteries of through traffic is demonstrated by the 60.4 per cent of the traffic on these roads originating outside of the county.

Table 4 shows that 81.4 per cent of the traffic on Michigan vehicles on the trunk-line roads, or 6,393,132 daily vehicle-miles, is of city origin. The total population of incorporated areas in Michigan in 1930 was 3,596,394, or 74 per cent of Michigan's population of 4,842,325. These facts indicate that residents of cities use the trunk-line roads to a slightly greater extent than the inhabitants of rural areas. However, the percentages are not greatly different, and they further emphasize the general character of the trunk-line roads.

On the city streets 31 per cent of the traffic, amounting to about 4,100,000 vehicle-miles per day, is of nonlocal origin. Part of this traffic is by vehicles from other cities and part by vehicles of rural origin. It would be useless to estimate these fractions, although the predominance of city traffic on the trunk lines suggests that the greater portion of the nonlocal city traffic comes from other cities. The traffic of city vehicles on township and county roads is shown in Table 4 to be 2,162,643 vehicle-miles per day, which is approximately half of the nonlocal traffic on city streets. It seems probable from these facts that the use of city streets by rural residents is not greatly different from the use of local rural roads by city residents, while the use of the trunk lines by the two classes of residents is approximately in the proportion of urban and rural population.

STREET AND HIGHWAY EXPENDITURES IN MICHIGAN

Financial data relating to highway expenditures in Michigan are not available for a period concurrent with the period of the traffic survey, although actual expenditures for that period may be closely approximated by available data. The financial statement of the State Highway Department covers the period July 1, 1930, to June 30, 1931, inclusive. Corresponding data for the townships, counties and cities are available for the calendar year 1930.

The records of the State Highway Department indicate total disbursements for the above-named period amounting to $45,582,894. Of this total, $10,622,880 represents direct payments of registration fees to the

counties, and $1,060,014 represents direct payments to cities for maintaining and widening trunk-lines through the cities, leaving a net total of $33,900,000 for construction, maintenance and overhead of the trunk-line highway system.

Replies to questionnaires sent to the counties give total receipts for highway purposes in the year 1930 of $32,376,706, and highway expenditures during the same year amounting to $28,185,300.

In the financial survey previously referred to, highway expenditures by local units covering the year 1930 were obtained. These figures show the expenditures for highways by townships and by five groups of incorporated places. They do not include the expenditures by the State, including Federal aid, or by the counties. They are strictly local expenditures made by the townships and the incorporated places under their own direction, and they include expenditures made and assessed against abutting property. These latter expenditures have not been usually included in the highway and street expenditures as commonly totaled for a State, so that the figures for Michigan are very much larger than those commonly published, but it has been assumed that assessments for street improvements, or rather expenditures for street improvements to be later collected from abutting property, are highway expenditures for that year within the meaning of the term.

A recapitulation of the net expenditures for highway purposes by units of Government is as stated in Table 8.

TABLE 8.—*Expenditures for highways by units of government during a 1-year period in 1930–31*

Governmental unit:		
State	$45, 582, 894	
Less payments to counties	10, 622, 880	
Less payments to cities	1, 060, 014	
		$33, 900, 000
Counties		28, 185, 300
Townships		6, 264, 384
Cities		37, 822, 997
Total		106, 172, 681

The expenditures listed in Table 8 are not annual highway costs, as they include capital expenditures as well as current items. Payments of bond principal are not included. State Highway Department expenditures during the years 1925 to 1929 ranged from 22 millions to 34 millions of dollars and averaged $26,600,000 per year. Expenditures for local highways during this period ranged from 21 millions to 43 millions of dollars and averaged $34,200,000 per year.

On the basis of the expenditures shown in Table 8 and the total annual traffic on each system, the expenditures per vehicle-mile on each of the highway systems of the State, including city streets, were computed and are as given in Table 9. It will be observed that the average for all highways of the State, including city streets, is 1.18 cents per vehicle-mile; and that the figures vary from 0.78 cent for city streets to 2.37 cents for county roads.

TABLE 9.—*Expenditures per vehicle-mile in 1930–31 on the several highway systems of Michigan*

Highway system	Expenditures per vehicle-mile	Annual vehicle-miles on system [1]
	Cents	
Township roads	1. 29	484, 647, 365
County roads	2. 37	1, 191, 399, 055
Trunk lines	1. 05	3, 213, 699, 440
City streets	. 78	4, 830, 371, 675
Average, all highways	1. 18	

[1] Based on Table 7.

These expenditure figures, although they can not be regarded as true annual costs, offer a basis of comparison with the reduction in cost per vehicle-mile in the operation of motor vehicles, effected by the improvement of roads. Data on this subject were developed in experiments by Prof. T. R. Agg, and reported in Bulletin 69 of the Engineering Experiment Station, Iowa State College, in 1924. Professor Agg's figures indicate that the average cost of operating an automobile over a high-type surface such as concrete, brick, or asphalt is approximately 2½ cents per mile less than the cost of operating over an ordinary earth road. A low-type surface such as gravel reduces operating costs about 1 cent per vehicle-mile; an intermediate surface, such as bituminous macadam, about 2 cents. A well-packed earth road, as opposed to average or ordinary earth roads, was shown to effect a reduction of about one-half cent per vehicle-mile.

From these figures it is evident that the expenditure of 0.78 cent per vehicle-mile on city streets, with a high type of improvement and dense traffic, is more than justified by the reduction in cost of operation of motor vehicles. The same is true of the trunk-line roads, which have an average traffic density of 1,144 vehicles per day, On the city streets and trunk-line highways the expenditures listed are chiefly for construction, maintenance playing a relatively small part in the total.

The county roads, which are mainly of intermediate and low types, and on which maintenance expenditures become more important, present a different situation. The expenditures per vehicle-mile amount to 2.37 cents. The average density of traffic on the county roads is 190 vehicles per day. This rate of expenditure can hardly be justified from the standpoint of economy in motor vehicle operation; and the fact that expenditures per vehicle-mile on county roads are conspicuously higher than on any of the three other classes of highway suggests that they may be excessive. It may be that the mileage improved has been overextended or that the type of improvement has been too expensive, or that a combination of these two factors has led to the high rate. In this connection it is noted that in Michigan, according to the latest available figures, there are 77,389 miles of local road, of which 33,408 miles, or 43.2 per cent, are surfaced. More than 97 per cent of the county highways are surfaced, and 27 per cent of the township highways are improved with gravel surface or a higher type. The surfaced local mileage for the United States as a whole in 1930 was but 17.5 per cent of the total.

It must be recognized that the county roads, on which 39 per cent of the traffic is of local (i. e. township) origin, render services, both social and economic, which can not be computed in terms of reduced transportation costs. However, there is a definite indication of over-expenditure; and plans for further development of the county system should take into account the extent to which the traffic justifies the outlay.

LOW TRAFFIC DENSITIES FOUND ON TOWNSHIP ROADS

Table 9 shows that the expenditures on the township roads in 1930–31 amounted to 1.29 cents per vehicle mile. This figure can not very well be compared with reduction in cost of motor vehicle operation. Seventy-three per cent of the township mileage is unimproved,

and corresponds to ordinary earth road, the lowest type considered in Professor Agg's figures, quoted above. It is doubtful if the expenditures on township roads could be said to produce a reduction of more than one-half cent per vehicle-mile in transportation costs.

The great bulk of expenditures on these roads is for maintenance, nearly all in the case of the unimproved roads. Reliable information as to the actual maintenance cost of township highways is difficult to obtain and but little has been written about this phase of highway economics.

Dividing the expenditure on township roads, as given in Table 8, $6,264,384, by the total mileage in the system, 60,214, we obtain $104 as the average expenditure per mile. This figure includes construction as well as maintenance costs. Township highway expenditures for the year 1930 were obtained from the State authorities for 78 townships. The reported expenditures for all these townships also averaged $104 per mile. The figures varied from very low values to over $500 per mile. Those townships in which the township highways were all unimproved (except for 1 mile) reported an average expenditure of $51 per mile. This figure is very near the minimum which could be expended with profit in maintaining an unimproved road.

The observed average daily traffic on township roads varied from less than one to 279 vehicles per day, the average being 22, and the median 20. Table 10 shows a percentage distribution of those township highways on which observations were made, on the basis of traffic density. The corresponding mileages, based on all the township mileage in the State, are also given. Thus we see that over half the mileage supports a traffic of 20 vehicles per day or less; about one-fourth has a traffic of 10 or less; and on nearly 14 per cent, or over 8,000 miles, the traffic is no more than 5 vehicles per day. If we apply the maintenance figure of $51 per mile to some of these low densities we obtain the following figures:

TABLE 10.—*Cumulative percentage of observed township mileage having traffic densities from 1 to 279 vehicles per day and corresponding mileages computed by applying these percentages to the total of township highway mileage in the State*

Average daily traffic density	Percentage of observed township mileage	Corresponding mileage based on all township mileage in State	Average daily traffic density	Percentage of observed township mileage	Corresponding mileage based on all township mileage in State
5 or less	13.58	8,177	40 or less	80.45	48,442
10 or less	25.51	15,361	45 or less	86.09	51,838
15 or less	39.58	23,833	50 or less	88.46	53,265
20 or less	51.90	31,251	75 or less	95.97	57,787
25 or less	63.16	38,031	100 or less	97.93	58,968
30 or less	70.73	42,589	150 or less	99.11	59,678
35 or less	76.65	46,154	279 or less	100.00	60,214

Expenditures per vehicle-mile

Vehicles per day:	Cents
1	13.97
5	2.80
10	1.40
20	.70

To set a limit, in terms of cents per vehicle-mile, on the expenditures to be made on such roads, would be an arbitrary procedure. It is clear, however, that a traffic of 1, 5, 10, or even more vehicles per day is insufficient for the reduction in transportation costs to pay the cost of maintenance. There are considerations more or less intangible which may justify high expenditures per vehicle-mile on very lightly traveled township roads. The State may be said to have a certain obligation, in connection with public education and the general welfare, to provide access to the land and homes of its citizens. This principle can not, of course, be pushed to the limit of building a road to the remotest habitation. The obligation exists none the less; and it would be well to recognize that a considerable portion of the expenditure on local roads must be justified by the general social and economic benefits to be derived.

APPENDIX

METHOD OF DETERMINING LOCAL TRAFFIC IN MICHIGAN CITIES

The use of city streets by residents and nonresidents was determined for the seven cities of Detroit, Grand Rapids, Flint, Lansing, Jackson, Ann Arbor, and Niles. These cities are representative of the population range from 10,000 to more than 1,500,000 and data obtained in them are applicable to other Michigan cities within this range.

Forty-three per cent of the passenger cars and 36 per cent of the trucks registered in Michigan in 1930 were registered in these seven cities. Their population in 1930 was 43 per cent of the population of the State, 57 per cent of the population of the 475 incorporated places in Michigan, and 63 per cent of the urban population of Michigan. Within these cities were 71 per cent of the registered motor vehicles of all cities with a population of 10,000 or over in 1930, and 70 per cent of the population of such cities.

A typical distribution of traffic stations is illustrated in the map of Flint, Figure 1. The stations are well distributed throughout the city and are sufficient in number to obtain data relative to all traffic movements within the city. All important sources of traffic were covered by stations. The trunk lines passing through Flint are shown by heavy lines on the map. The distribution of stations is similar to that in all of the cities except Detroit. In that city traffic stations were located on three cordons.

The inner cordon covered all intersections on Grand Boulevard; the middle cordon was on Artillery, Livernois, Davison, Six Mile Road, and Conners Streets; the outer cordon was on Eight Mile Road and at the crossings of the River Rouge near the east city limits. One hundred and sixty-four stations were located on these three cordons at points used by the Rapid Transit Commission in their study of vehicular traffic.

Traffic counts were taken in the seven cities during the month of August, 1931. Vehicles were classified as local, nonlocal, or non-Michigan. Local traffic was identified through the registration numbers assigned for cars of each city by the State Motor Vehicle Director. The correctness of such classification was checked by noting the license numbers and determining the domicile of the owner, in order to eliminate from the local classification those vehicles whose owners bought tags in the city but who were not domiciled within the city limits.

Where the volume of traffic was not too heavy all cars were classified and the domicile of the owner determined. Where this could not be done, as many license numbers as possible were noted and later classified. About one in each three license numbers was taken for investigation upon each route at a station.

A certain percentage of apparent local traffic (i. e., vehicles carrying tag numbers assigned to the city of observation) was found to be of nonlocal origin. This percentage was applied to each original count of vehicles and the traffic of true local origin determined. For example, at station 27 in Grand Rapids 1,551 cars with apparent local tags were noted on the north route at the intersection of Ionia Avenue and Crescent Street on Monday, August 24, during the hours from 10 a. m. to 8 p. m. Examination disclosed that 137, or 8.8 per cent of these cars were owned outside of Grand Rapids. The vehicle count on this route totaled 3,492 apparent local cars. Subtracting 307 or 8.8 per cent of the count gave 3,185 local vehicles. The 307 so deducted were added to the nonlocal classification.

Population and type of traffic.—The ratio of local traffic to total traffic ordinarily increases with population. In Figure 2

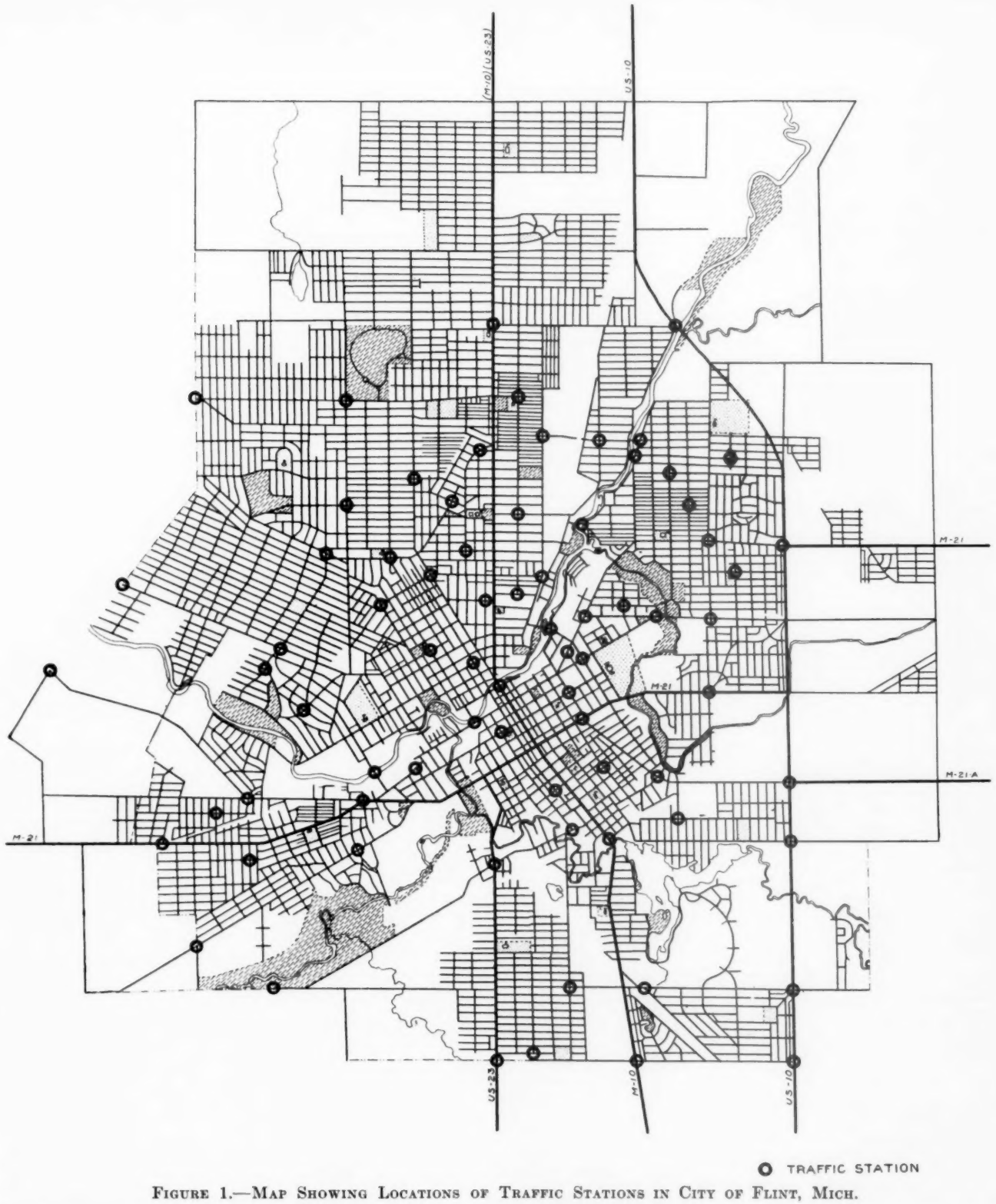


FIGURE 1.—MAP SHOWING LOCATIONS OF TRAFFIC STATIONS IN CITY OF FLINT, MICH.

the percentage of local traffic (determined by weighting percentages on through and nonthrough streets by mileage in each class) is plotted against population and a trend line drawn. With the exception of Jackson and Lansing, it is apparent that the larger the city the greater the percentage of local traffic. After a population of 180,000 is reached, the effect of increases in population upon the percentage of local traffic is very small. Detroit with nearly nine times the population of Grand Rapids, had but a slightly higher percentage of local traffic, although the volume of Detroit traffic is several times that of Grand Rapids.

Through street mileage and type of traffic.—Since the data for Jackson and Lansing do not agree with the population-local traffic trend, and because there are other cities of about this size for which traffic data were not taken, another method was developed as a check and a modifier of the results obtained by considering population and percentage of local traffic. This was

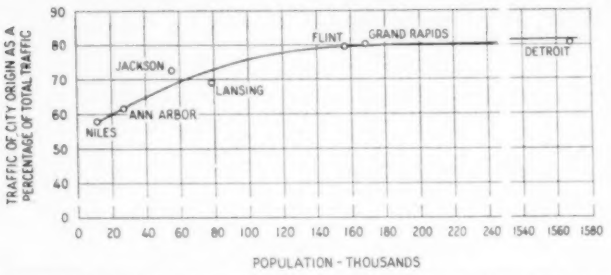


FIGURE 2.—RELATIONSHIP BETWEEN LOCAL TRAFFIC ON CITY STREETS AND POPULATION OF CITIES; PERCENTAGE OF LOCAL TRAFFIC DETERMINED BY WEIGHTING PERCENTAGES ON THROUGH AND NONTHROUGH STREETS

done by plotting the ratio of through street mileage to total mileage for each city against the percentage of local traffic observed in each of the seven cities. There is an inverse relationship between these two factors as shown in Figure 3.

With a trend line through the points thus obtained, it is possible to determine the percentage of local traffic for any city if its ratio of through street mileage to total mileage is known, thus enabling close estimates of percentage of local traffic in those cities where no traffic data were obtained.

The average percentage of local traffic for a number of cities combined, when derived by both methods, varies only slightly. From consideration of data from the seven cities studied it appears that the relationship of percentage of through street mileage to local traffic provides an excellent check upon the population-local traffic relationship, and that it may be a better measure of local traffic in the individual city.

Although Jackson and Lansing diverge from the population-local traffic trend in the percentage of through street mileage-local traffic relationship, they are on or very near the trend line, but in reverse order. In Figure 3 Grand Rapids and Detroit are farthest from the trend line and on opposite sides. Grand Rapids has an unusual number of parallel through streets. More Streets in Detroit might properly be included in the through-street mileage (thus bringing this city closer to the trend line), but were not so included in conformance with the definition of through routes. There is also the fact that in Detroit through streets are much wider than local streets, so that the area of through-street mileage and that of local-street mileage is more nearly in proportion to that of the other cities.

Local traffic in Detroit and adjacent cities.—As previously noted, the traffic stations in Detroit were located on three cordons. These cordons were located at about 3, 6, and 8 miles from the center of the city.

Table 1 gives detailed figures for local traffic on each cordon as well as for each section of the cordons. The percentage of local traffic at each cordon was as follows: Inner, 81.2; middle, 81; and outer, 65.8. The observed local traffic at all cordons combined was 79.9 per cent.

TABLE 1.—*Local traffic at Detroit cordons*

Section	Inner cordon		Middle cordon		Outer cordon	
	North and South	East and West	North and South	East and West	North and South	East and West
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
East side	81.0	84.8	83.3	84.2	77.7	78.1
North side	83.0	81.0	77.6	81.9	61.7	64.6
West side	79.2	80.0	82.3	78.2	.....	58.8
Total	81.2		81.0		65.8	

The traffic of cities within and surrounding Detroit differs from that of an average city of similar size located at a distance from a large city. Hamtramck and Highland Park are within the corporate limits, but are not a part of Detroit. Local traffic in these places is similar to that of Detroit considering the entire area as a unit. Several of the Detroit traffic stations on the middle cordon were located in Highland Park. The counts at these stations showed that Detroit accounted for 77.4 per cent of the traffic, and 2.6 per cent originated outside of the State. Only 20 per cent was originated in Highland Park and the rest of Michigan outside of Detroit.

The population-local traffic relationship indicates a percentage of local traffic for Highland Park of less than two-thirds that of Detroit, while the percentage of through street mileage-local traffic relationship indicates a percentage of local traffic a little less than that of Detroit. Either method indicates a figure several times the observed local traffic. It is only logical to expect local traffic in Hamtramck and Highland Park to be very much like, if not identical with, that of Detroit if all three were combined as a metropolitan area.

Combining all these suburban places into one area and treating them as a Detroit metropolitan area brings the whole in nearer agreement to the trend line of Figure 2.

Method of estimating local traffic in all cities of State.—In arriving at estimates of the average percentage of local traffic in Michigan cities the two methods previously explained were used. The percentage of local traffic in the cities of the survey, when determined by population ratios, by ratio of through street mileage to total mileage, and by actual count, is not always the same, as will be seen by referring to Figures 2 and 3. Location of a town or city on heavily traveled through routes near a large city, or some other determining factor for the particular city, may be of great importance in arriving at the correct percentage of local traffic for a city. The heavy traffic on through routes passing through a small town lowers the ratio of local traffic to total traffic to a very low figure as compared with that of a town of the same size not on a through route, or on a through route with a much lower volume of traffic.

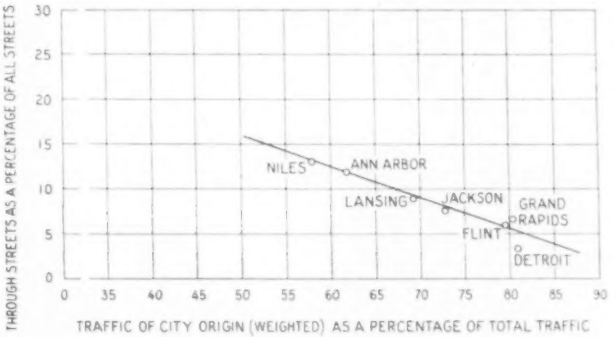


FIGURE 3.—RELATIONSHIP BETWEEN LOCAL TRAFFIC ON CITY STREETS AND MILEAGE OF THROUGH STREETS; PERCENTAGE OF LOCAL TRAFFIC DETERMINED BY WEIGHTING PERCENTAGES ON THROUGH AND NONTHROUGH STREETS BY MILEAGE IN EACH CLASS

Since no towns or cities under 10,000 population were included in the cities surveyed, an estimate of local and nonlocal traffic for these can be made on the basis of the trend line of Figure 2 extended or the ratio of through street mileage to total mileage as scaled from maps.

However, in the application of the through-street percentage relationship to small towns, it seems reasonable to include county routes which enter the town as connections with State or Federal-aid routes in the through-street mileage. It appears that county routes leading into small towns have about the same effect upon local traffic as have State routes entering larger cities. In fact, some towns have no State routes passing through them, so it is necessary to use county routes.

Whatever the method used to determine the percentage of local traffic in places under 10,000 population, it will have little effect on the mean local traffic for all Michigan cities combined. Including all incorporated places under 10,000 population, however small, the average percentage of local traffic for these would have to vary more than 10 per cent to affect the mean local traffic of all Michigan cities combined by as much as 2 per cent.

If all incorporated places under 10,000 population had been included in the city survey, it is doubtful if the combined average would vary materially from an average arrived at by use of either the population or through-street percentage relationships to local traffic.

Local traffic at single stations on through routes varies from 8 to 54 per cent for towns and cities of varying sizes under 10,000 population. One town under 1,000 population had 14 per cent local traffic on two intersecting streets combined but on one of these streets the local traffic was 43 per cent. The other street was a heavily traveled through route which greatly reduced the average for both streets.

In estimating the percentage of local traffic in towns and cities under 10,000 population, all of these cities were considered as an average city within the group. Also, sample towns were con-

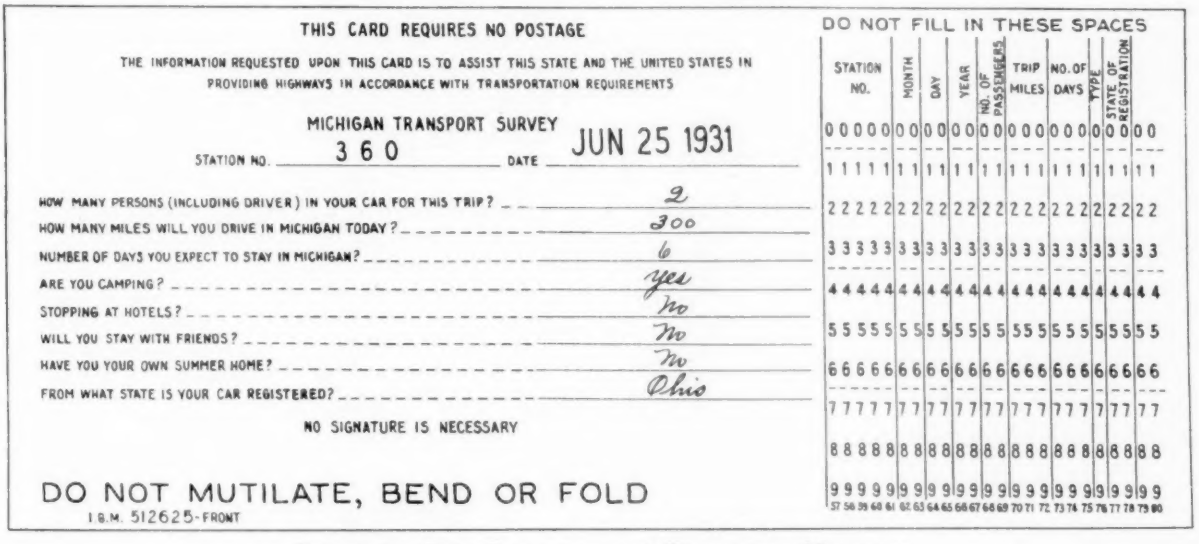
(Continued on p. 200)

MOTOR TOURIST TRAFFIC IN MICHIGAN

By the Bureau of Public Roads, United States Department of Agriculture, and the Michigan Highway Department

THE following analysis of motor tourist traffic is based upon post-card questionnaires distributed during the course of a traffic survey extending from July, 1930, to July, 1931. A sample card is shown in Figure 1. More than 42,000 of these cards were returned, and all sections of the State are represented. central plains States. Of the traffic from the central plains States, more than one-third originates in Minnesota.

A classification of tourist cars by type of accommodation, Table 2, indicates that more than one-third of the total number of visitors stayed with friends, nearly



THIS CARD REQUIRES NO POSTAGE

THE INFORMATION REQUESTED UPON THIS CARD IS TO ASSIST THIS STATE AND THE UNITED STATES IN PROVIDING HIGHWAYS IN ACCORDANCE WITH TRANSPORTATION REQUIREMENTS

MICHIGAN TRANSPORT SURVEY

STATION NO. 360 DATE JUN 25 1931

HOW MANY PERSONS (INCLUDING DRIVER) IN YOUR CAR FOR THIS TRIP? 2

HOW MANY MILES WILL YOU DRIVE IN MICHIGAN TODAY? 300

NUMBER OF DAYS YOU EXPECT TO STAY IN MICHIGAN? 6

ARE YOU CAMPING? yes

STOPPING AT HOTELS? no

WILL YOU STAY WITH FRIENDS? no

HAVE YOU YOUR OWN SUMMER HOME? no

FROM WHAT STATE IS YOUR CAR REGISTERED? Ohio

NO SIGNATURE IS NECESSARY

DO NOT MUTILATE, BEND OR FOLD

I.B.M. 512625-FRONT

DO NOT FILL IN THESE SPACES

STATION NO. | MONTH | DAY | YEAR | NO. OF PASSENGERS | TRIP MILES | NO. OF DAYS | TYPE | STATE OF REGISTRATION

FIGURE 1.—CARD DISTRIBUTED TO TOURISTS IN MICHIGAN

All operators of foreign cars were given cards at stations near the border but since stations were not operated continuously the operators stopped at stations in the interior of the State and found to be without such a card were given one. The information upon these cards, supplemented by special data obtained at the Ambassador Bridge, the Detroit-Windsor Tunnel, and all ferries, furnished data with regard to tourist and Canadian traffic movements.

The origin of tourist cars is summarized in Table 1, and also in Figure 2, in which the percentage of tourist

TABLE 1.—*Origin of tourist traffic in Michigan during 1930–31, as indicated by questionnaire cards*

State, country, or group	Number of cards returned	Percentage of total
Wisconsin	2,528	6.0
Illinois	13,608	32.5
Indiana	8,115	19.4
Ohio	8,942	21.4
Canada	1,168	2.8
Total, neighboring States and Canada	34,361	82.1
New England States	410	1.0
Northeastern States	2,382	5.7
Southeastern States	992	2.4
Central States	2,823	6.7
Western States	901	2.1
Total	41,869	100.0

traffic originating in the areas indicated is proportional to the area of the circle in each case. Most of this traffic originates in the States adjoining Michigan and in Canada, this area contributing 82.1 per cent of the total tourist traffic. The remaining 18 per cent originates in all parts of the United States, the bulk of it coming from the northeastern States and from the

24 per cent at hotels, and more than 19 per cent at summer homes. These three important groups comprise four-fifths of the total. More than half of the remainder proceeded directly through the State, making no overnight stops. Camping parties represent only 6 per cent of the total, and the miscellaneous group, those cars which could not be conveniently classified under any of the above types, 4 per cent.

The average number of persons per car in all tourist cars was 2.8. More than one-half of the total cars carried 1 or 2 persons and nearly 70 per cent carried 1, 2, or 3 persons. Every sixth car carried four persons, but the number of cars carrying five or more persons was only a small part of the total.

TABLE 2.—*Distribution of tourist cars by type of accommodation*

Type	Number of cars	Number of cars as percentage of total	Number of persons	Number of persons as percentage of total
Friends	14,094	33.53	43,638	36.84
Hotels	12,348	29.38	27,999	23.64
Summer home [1]	7,622	18.13	23,232	19.61
Through traffic	4,021	9.57	11,793	9.96
Camping [2]	2,236	5.32	7,095	5.99
Miscellaneous [3]	1,712	4.07	4,694	3.96
Total	42,033	100.00	118,451	100.00

[1] "Summer home" includes all cars where possession of a summer home was indicated, on the assumption that other types of accommodation were used only incidentally in going to and from the summer home.

[2] Includes camping and friends.

[3] Miscellaneous includes cars unclassified according to type, and the minor groups: Hotels and camps; hotels and friends; and, hotels, camps, and friends.

The average length of stay for all classes of tourists is 11 days per party. It ranges from one day, reported by one car in every five, to more than six months. The

greatest number of visits are of short duration. Nearly 40 per cent of all parties stayed two days or less, while visits of one week or less were made by nearly three-fourths of all parties. Table 3 gives the length of stay of tourist cars, in percentages distributed by type of accommodation used.

There is naturally a considerable difference in the average length of stay of the various types of tourists, ranging from 7.5 days for those staying with friends, to 24 days for those using their own summer homes. The average stay for those staying at hotels is 8.2 days, and that for campers is 10.6 days.

TABLE 3.—*Length of stay of tourist cars in percentages distributed by type of accommodation used*

Number of days	Friends	Hotels	Summer home	Camping	Miscellaneous	Total
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1	19.8	17.2	16.5	12.5	6.8	21.0
2	21.2	20.7	15.0	15.7	12.5	18.2
3	15.1	13.3	9.9	11.8	10.9	12.5
4	9.0	8.7	5.3	7.2	9.7	7.8
5	5.3	7.4	3.5	5.1	7.3	5.4
6	2.9	3.6	2.0	4.5	4.9	3.0
7	6.1	5.0	4.2	7.6	7.6	5.3
8	1.3	1.3	.9	2.7	2.9	1.3
9	.3	.4	.4	.8	1.0	.4
10	4.8	6.1	4.4	7.6	7.8	5.2
11	.2	.2	.1	.4	.6	.2
12	.7	.7	.8	1.6	1.6	.8
13	.1	.1	.1	.2	.1	.1
14	3.9	3.9	3.7	6.7	6.7	4.0
15	1.0	1.3	1.1	1.8	2.1	1.2
16	.2	.2	.3	.4	.3	.2
17		.1	.2		.1	.1
18	.2	.4	.3	.6	.2	.3
19				.1	.1	
20	.6	.7	.7	.8	1.4	.7
21 to 30	1.4	2.4	2.6	2.7	2.8	2.0
STAY IN MONTHS						
1 to 2	3.4	3.9	6.9	5.1	6.3	4.3
2 to 3	1.3	1.3	10.4	2.7	3.2	3.1
3 to 4	.9	.8	8.3	1.1	1.6	2.2
4 to 5	.1	.1	1.4	.2	.1	.3
5 to 6			.4		.2	.1
6 to 12	.2	.2	.6	.1	1.2	.3
Total	100.0	100.0	100.0	100.0	100.0	100.0
Average (days)	7.5	8.2	24.0	10.6	14.7	11.0
Median (days)	3.6	3.9	4.5	5.5	6.6	3.9

ESTIMATE OF TOURIST EXPENDITURES

The information concerning length of stay, type of accommodation, and average number of passengers may be applied to the total incoming tourist traffic to estimate the value of this traffic in terms of expenditures within the State. However, the accuracy of such an estimate depends primarily on the estimate of the average expenditure per tourist per day, and very little accurate data [1] has been collected on this point. The final estimate here given is regarded merely as an indication of total tourist expenditures, but conservative figures have been used throughout and it is, therefore, probable that the actual expenditure is greater than the estimate.

As the cost of car operation is an item of expense for all types of motor tourists, it is convenient to assume an average cost per mile and apply this figure in the estimate for each type. The following estimate of car-operation costs is based upon the assumption that the average tourist car is a light 6-cylinder model. Cars of this type were used by recorders and supervisors in the survey, and the following unit costs are, therefore, taken directly from the cost records of these cars:

Average miles per gallon of gasoline	17
Average miles per quart of oil	100
Average cost per gallon of gasoline	$0. 17
Average cost per quart of oil	.27
Cost of gasoline per mile	.010
Cost of oil per mile	.003
Miscellaneous costs per mile	.005
Total cost of operation per mile	.018

FIGURE 2.—ORIGINS OF MOTOR TOURIST TRAFFIC IN MICHIGAN. SIZE OF CIRCLE INDICATES RELATIVE NUMBER OF TOURISTS FROM EACH AREA

This figure of $0.02 per mile may appear to be too conservative, but it should be remembered that it represents only direct operation expenditures which would be made in Michigan during a visit. Indirect costs such as depreciation, license fees, etc., are not considered.

Table 4 is an itemized estimate of the daily expenditures per person for the six tourist types. The estimate for the summer-home group is based upon an assumed average home value of $3,000, upon which carrying charges and all operating costs on a yearly basis will approximate 10 per cent of the value, or $300. This expenditure is charged against a season of 100 days, resulting in the equivalent of a rental value of $3 per day, or $1 per day per person for a party of three.

TABLE 4.—*Itemized estimate of expenditures per person per day for various types of tourists*

Items	Friends	Hotels	Summer home	Camping	Through	Miscellaneous
Average number of persons per party [1]	3.1	2.3	3.1	3.2	2.9	
Average daily miles per car	50	100	50	100	[2] 120	
Cost of car operation at $0.02 per mile	$1.00	$2.00	$1.00	$2.00	$2.40	
Cost of garaging		.75				
Total car operation cost per day	1.00	2.75	1.00	2.00	2.40	
Cost of car operation per person per day	.32	1.20	.32	.62	.83	
Cost of lodging per person per day		[3] 2.70	[4] 1.00	.75		
Cost of food per person per day	.75	2.25	.75	1.00	1.50	
Miscellaneous costs per person per day	.75	1.50	.75	1.00	.50	
Total expenditures per person per day	1.82	7.65	2.82	3.37	2.83	[5] 3.70

[1] Most of the estimates of the value of tourist traffic have been made by tourist associations and automobile clubs. In the majority of cases, the estimates are based frankly upon guesses as to the average expenditure per person per day. Several studies of considerable merit have been made by means of questionnaires and wherever possible the following estimates of expenditures by the various types of tourists have been checked against these studies.

[1] Averages obtained from questionnaires.
[2] Average obtained from questionnaires. All other daily mileages are estimates, as the averages obtained from the questionnaires are not considered representative averages for daily mileage for the entire length of stay.
[3] Based on an assumed cost of $4 per day for one person; $5 per day for two persons, and reduced to a unit cost for a party of 2.3 persons.
[4] Based on an average rental value of $3 per day for a period of 100 days.
[5] Arithmetic average of the expenditures for all other types.

The average daily mileages per car given in Table 4 were estimated, except in the case of the cars passing through the State, for which the average obtained from the questionnaires was used. The questionnaire averages in general refer to daily mileages while touring, and are not representative of the daily travel of parties making an extended stay in the State. The estimates used represent an attempt to allow for both the trip mileage in and out of the State, and the daily use of the vehicle during the sojourn.

The average daily volume of foreign cars at selected border stations was used in computing the total yearly volume of tourist traffic. A considerable portion of foreign traffic near the border is an "over-the-line" movement of cars for business purposes, and it was necessary to apply an appropriate correction at each station to eliminate this traffic. The proportion of cars staying one day or less from the State immediately adjacent to each station as obtained from the questionnaire cards was considered a reliable indication of this business traffic. These proportions were accordingly applied to the total foreign traffic at each station under consideration and the remainder was assumed to represent the true volume of tourist traffic, shown in column six of Table 5. The total daily volume of tourist traffic at all border stations was 13,700 cars per day and represents both incoming and outgoing cars. One-half of the above total, or 6,850 cars per day, may be considered as incoming tourist cars, or 2,500,000 cars per year.

TABLE 5.—*Estimate of automobile tourist traffic per year*

Station	Route	Direction	Daily foreign passenger cars	Reduction factor	Net daily foreign passenger cars
1	Ferry		869	0.96	845
2	do		657	.87	571
3	do		711	.86	611
4	do		195	.90	176
5	do		6	1.00	6
6	do		4	1.00	4
7	do		234	.78	182
8	do		94	.85	80
249	US 12	N. and S.	2,546	.71	1,808
250	CR	S.	121	.67	81
251	US 31	N. and S.	1,976	.67	1,324
260	US 27	S.	398	.81	326
280	US 112	S.	851	.76	647
320	US 2	W.	173	.93	161
321	US 141	SE.	291	.84	244
351	US 2	E. and W.	197	.94	185
353	M 62	W.	62	.89	55
355	M 26	N. and S.	82	.87	71
372	M 34	S.	58	.82	48
410	M 73	SW.	45	.92	41
412	US 2	S.	76	1.00	76
468	M 34	W.	53	.91	48
-----	CR	S.	36	.91	33
474	M 52	S.	155	.59	91
519	CR	W.	13	.92	12
521	US 41	S.	154	.87	134
522	M 35	S.	108	1.00	108
538	US 223	N.	1,127	.60	676
539	US 23	N.	1,086	.81	880
540	US 24	N. and S.	2,312	.88	2,034
541	US 25	N. and S.	1,795	.88	1,580
653	TR	S.	20	.82	16
654	US 131	S.	593	.85	504
655	CR	S.	7	.82	6
838	CR	W.	9	1.00	9
944	CR	S.	28	1.00	28
	Total per day				13,701
	Incoming per day				6,850
	Incoming per year				2,500,250

In Table 6 the estimated expenditures of the various types of tourists and the percentage of each type are applied to the total incoming traffic to obtain the total expenditures for each type. The total expenditures of all motor tourists were approximately $274,000,000. While this estimate is admittedly an approximation, it serves to impress the tremendous value of this traffic to the State. Total foreign vehicle-mileage indicates a consumption by foreign cars of more than 30,000,000 gallons of gasoline, and gasoline taxes paid by owners of foreign vehicles amounts to more than $900,000 annually.

TABLE 6.—*Estimated yearly tourist expenditures by types*

Type	Person-days per car [1]	Expenditures per person-day	Expenditures per car per visit	Cars entering per year	Expenditures per year
Friends	22.1	$1.82	$40.22	837,500	$33,700,000
Hotels	17.5	7.65	133.88	735,000	98,400,000
Summer home	77.6	2.82	218.83	452,500	99,000,000
Camping	31.6	3.37	106.49	240,000	25,600,000
Through	3.0	2.83	8.49	132,500	1,100,000
Miscellaneous	43.0	3.70	159.10	102,500	16,300,000
	31.6	3.47	109.64	2,500,000	274,100,000

[1] Since unit expenditures were estimated on a person-per-day basis, length of stay is expressed in the unit "person-days" for purposes of computation. It does not correspond exactly to the figure obtained by multiplying the average number of persons per car by the average stay per car because the average number of persons per car varies by length of stay as well as by type.

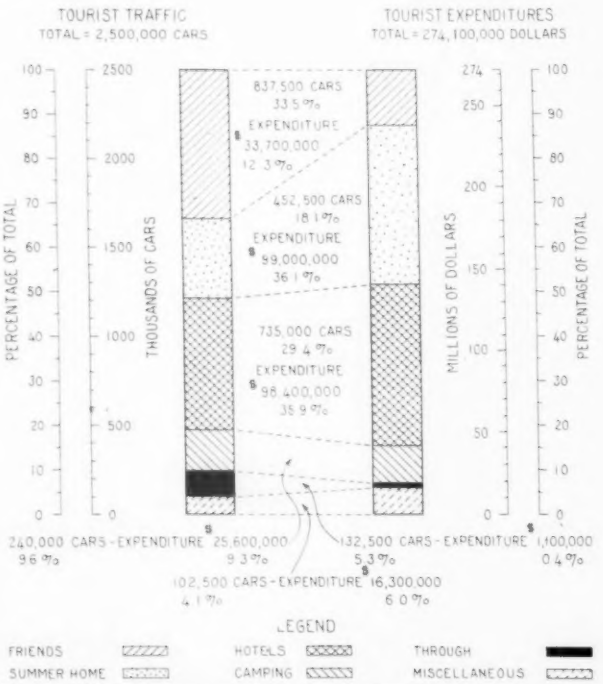


FIGURE 3.—NUMBER OF TOURIST CARS AND ESTIMATE OF EXPENDITURES BY CLASS OF TOURIST

Of equal if not greater importance than the total expenditures of motor tourists is the relation between the volume of each type of tourist traffic and the expenditures of that group. Tourists owning their own summer homes, representing only 18.1 per cent of the total tourist traffic, are responsible for 36.1 per cent of the total tourist expenditures, more than any other group. Furthermore, the expenditures per visit of this class are considerably greater than that of any other, and the advantage of endeavoring to increase the number of this kind of tourists is apparent. Only slightly less valuable is the hotel visitor. The group using hotels forms 29.4 per cent of the total traffic, but spends $98,400,000 per year, nearly 36 per cent of the total. These two groups, comprising slightly less than one-half of the traffic spend nearly three-fourths of the total expenditures.

These relationships between volume of traffic and expenditures for the various types of tourists are shown in Figure 3.

There is an important interchange of traffic along the Canadian border, but what might be termed the "balance of tourist trade" is heavily in favor of Canada, considerably more cars bearing Michigan tags or those of other States entering Canada than enter Michigan with Canadian tags. At eight ferries and bridges there was an average passenger car volume of 9,696 per day. Michigan cars constituted 71.4 per cent of the total, cars from other States, 9.0 per cent, and Canadian cars, 19.6 per cent, as shown in Table 7.

The greatest volume of this traffic naturally occurs between Detroit and Windsor, the Ambassador Bridge carrying an average of 3,255 cars per day; the Bates Street Tunnel, 2,141; the Windsor Ferry, 2,504; and the Walkerville Ferry, 986. The largest part of this traffic is probably an exchange of business traffic between Detroit and Windsor, but there is a very considerable volume of tourist traffic, as indicated by the volume of traffic at these points from other States. Detroit is a convenient point of entry into Canada for tourists from the United States because it is the terminus of main highways from Chicago and Toledo, while Windsor is the terminus of a popular route from Niagara Falls.

TABLE 7.—*Density of traffic at bridges and ferries connecting with Canada*

Location	Average daily passenger cars							Average daily passenger cars and trucks
	Michigan cars		Foreign cars				Total	
			Canadian cars		Other cars			
	Number	Per cent	Number	Per cent	Number	Per cent		
Ambassador Bridge	2,386	73.3	449	13.8	420	12.9	3,255	3,401
Bates Street Tunnel	1,484	69.3	497	23.2	160	7.5	2,141	2,164
Windsor Ferry	1,793	71.6	573	22.9	138	5.5	2,504	2,581
Walkerville Ferry	791	80.2	164	16.6	31	3.2	986	1,101
Port Lambton Ferry	27	81.8	5	15.2	1	3.0	33	34
St. Clair Ferry	17	85.0	3	15.0	(1)	.....	20	22
Port Huron Ferry	354	60.2	158	26.9	76	12.9	588	592
Sault Ste. Marie Ferry	75	44.4	48	28.4	46	27.2	169	177
Total and percentage	6,927	71.4	1,897	19.6	872	9.0	9,696	10,072

[1] Less than one car per day.

Traffic of Canadian cars between Detroit and Windsor aggregates 1,683 per day, nearly one-fifth of the total, and card returns indicate that about 50 per cent of this volume is tourist traffic.

Traffic at other points along the Canadian border is very much lighter than at Detroit, although there is a considerable volume at Port Huron and Sault Ste. Marie. The Port Huron Ferry carries an average of 588 passenger cars per day—60.2 per cent being Michigan cars, 12.9 per cent from other States, and 26.9 per cent from Canada. The ferry at Sault Ste. Marie carries an average daily traffic of 169 cars—44.4 per cent of which are from Michigan, 27.2 per cent from other States, and 28.4 per cent from Canada. The ferries at Port Lambton and St. Clair are not on main routes, and, in consequence, carry a relatively small volume of traffic.

(Continued from p. 196)

sidered in connection with the through-street-mileage relationship. Studying all available data the typical city for the group under 10,000 population was estimated to have 43 per cent local traffic.

Table 2 presents the data on city traffic of local origin for all cities in Michigan. Detroit is listed separately in the table because of its size and effect upon any average. The other six sample cities are listed next and in combination with Detroit. Then follows the data for group 1 and group 2 cities. Group 1 cities are those for which street mileage data, as well as population, are available. Group 2 cities are those with more than 10,000 population, but for which the mileage data are lacking. These are followed by the large group of towns and cities under 10,000 population.

The procedure used in combining the results in the Michigan cities was as follows: (1) Field data for the seven sample cities were summarized; (2) percentage of local traffic determined by the population-local traffic relationship; (3) percentage of local traffic determined by the use of through street percentage-local traffic relationship; (4) a final average secured by a combination of the results of 2 and 1, and 3 and 1, using the weighted average for each.

TABLE 2.—*Percentage of traffic of local origin in all Michigan cities*

City group	Population	Weighted average percentage of local traffic, as determined by—	
		Population of city	Mileage of through streets
		Per cent	Per cent
Detroit [1]	1,569,000	80.9	80.9
Six other cities of survey [1]	496,000	76.1	76.1
Seven cities of survey combined [1]	2,065,000	79.7	79.7
Cities over 10,000, group 1	572,000	64.8	65.6
Cities over 10,000, group 2	296,000	64.1	[3] 64.5
All cities over 10,000 combined	2,933,000	75.2	75.4
Cities under 10,000 [2]	663,000	43.0	43.0
All Michigan cities	3,596,000	69.3	69.5

[1] Actual percentages, from field data.
[2] Estimated from group 1 cities.
[3] Estimate determined by use of both population and through street mileage.

The percentages of local traffic in the third column of Table 2 are either the weighted averages obtained from field observations, or are obtained from the data of Figure 2. These percentages are weighted by the population of the city or group of cities to give an average of 69.3 per cent local traffic. The percentages of the last column are those obtained from the field data or from the data of Figure 3 and are again weighted by population to give a combined figure of 69.5 per cent local traffic in the cities of Michigan as a whole.

The differences in the final percentages obtained are slight, the figures varying from 69.3 to 69.5 per cent local traffic for the State as a whole. Since the weighted average for traffic of city origin probably best represents the actual condition, and since the unweighted averages vary little from the above figures, the final percentage of local traffic for all incorporated places in Michigan is estimated to be 69 per cent of the total traffic of these cities.

CORRECTION

Vol. 13, No. 10, December, 1932.—In the article entitled "The Problem of Motor Vehicle Regulation," Appendix B, page 168, the following note was included under the heading "Remarks," and appeared opposite the entries for the State of Maine:

Truck tractor, 4-wheel semi and 6-wheel full trailer, maximum gross 80,000 pounds. No combination including more than 1 semitrailer or full trailer may be operated at more than 10 miles per hour.

The note should be read to apply to the State of Maryland.

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